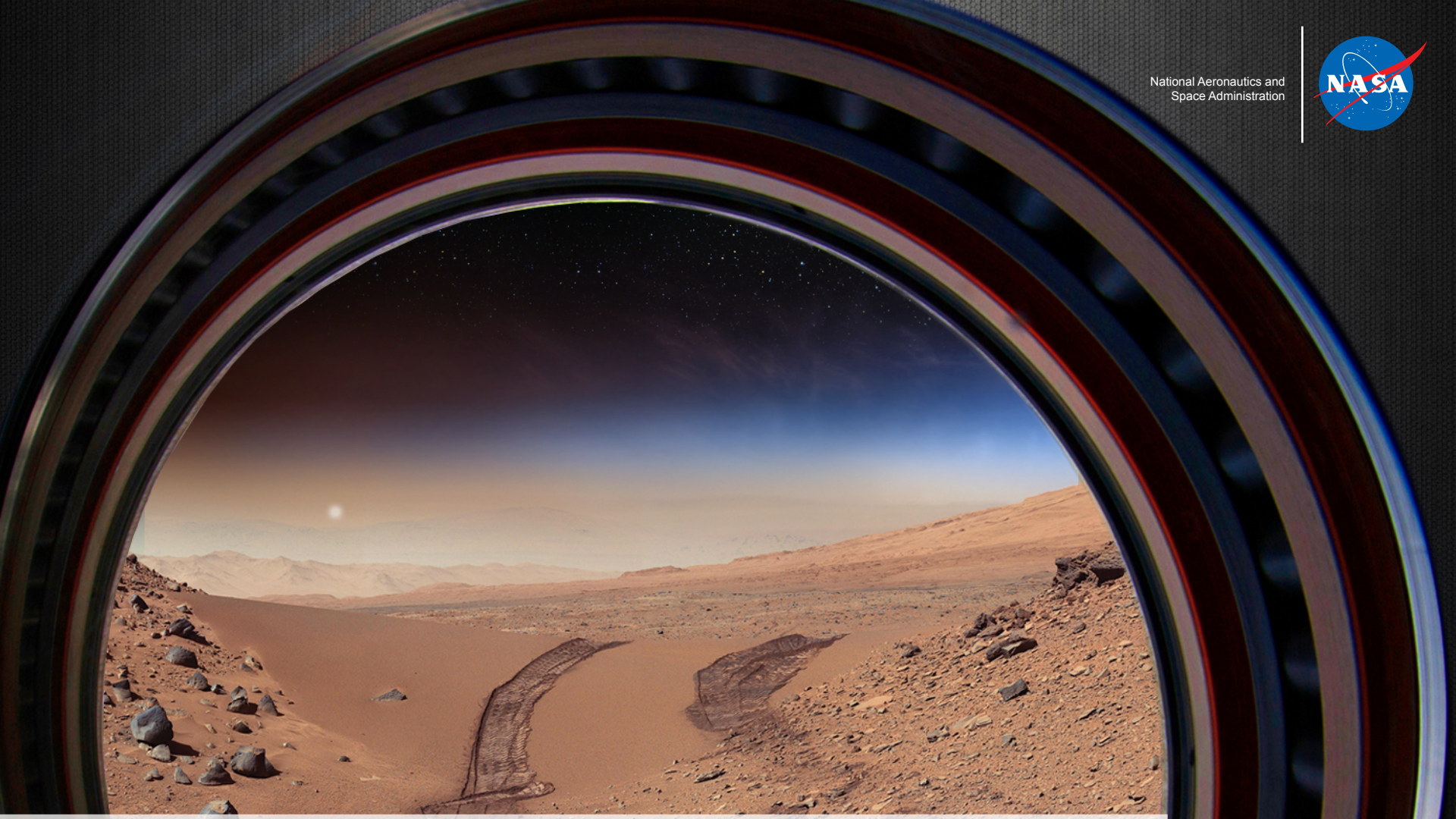


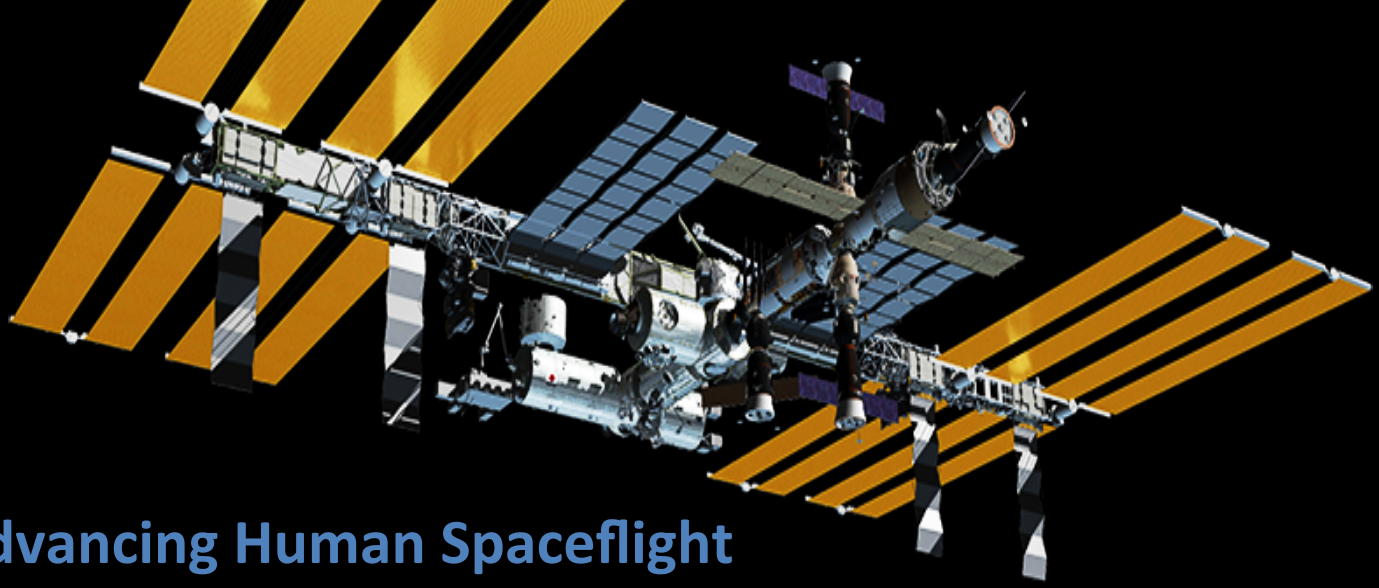
National Aeronautics and Space Administration

Commercial Crew Program (CCP) Status

Philip McAlister / NAC HEO Subcommittee / July 2016

Agenda

- Commercial Crew Program (CCP) Highlights
- Major Contract Milestone Status
- Space Act Agreement Status
- CCP Top Program Risks
- Boeing Summary
- SpaceX Summary
- Budget
- Conclusion



Advancing Human Spaceflight

The vision of commercial human spaceflight to low-Earth orbit is a robust, vibrant enterprise with many providers and a wide range of private and public users.
A successful human space transportation system will strengthen the International Space Station Program, allow NASA to focus on deep-space exploration, potentially reduce the cost of human access to space and significantly contribute to the national economy.

CCP Public Purpose

Support the development of non-NASA markets for commercial human transportation services to and from low-Earth orbit.

CCP NASA Purpose

Safe transport of NASA and NASA-sponsored astronauts to and from the station.

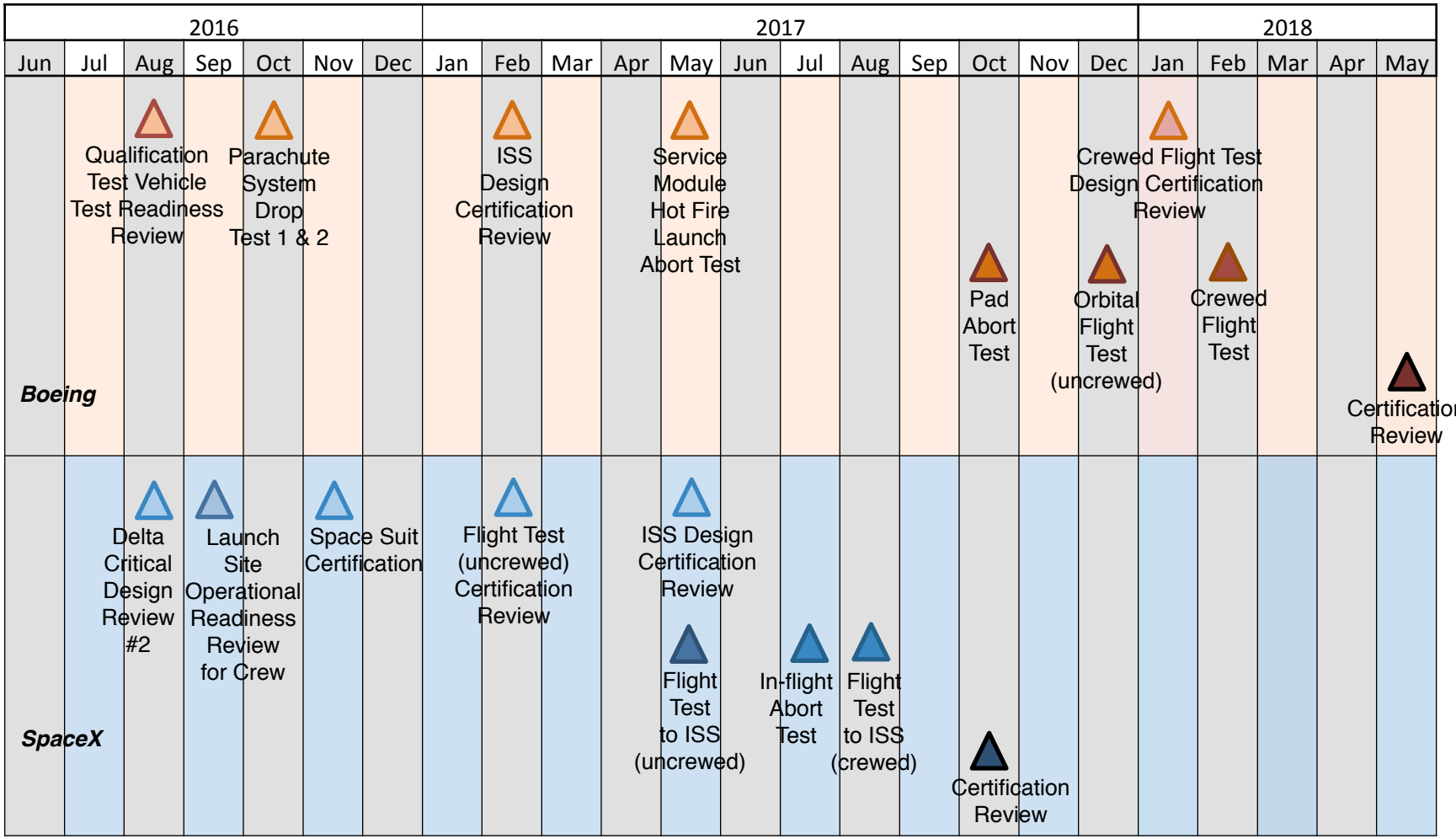
Highlights

CCP has made significant progress over the last quarter, notably:

- **Continue to burn down key products with the providers**
  - Over 90% of the alternate standards are completed
  - Over 60% of the variances are completed
  - Over 60% of the Phase 2 hazard reports are completed

- **Eight CCP missions now in process:**
  - For SpaceX:
    - Uncrewed and crewed test missions
    - PCM-1 awarded November 2015; Completed one milestone to date
    - PCM-2 award expected in August 2016
  - For Boeing:
    - Uncrewed and crewed test missions
    - PCM-1 awarded May 2015; Completed three milestones to date
    - PCM-2 awarded in December 2015; Completed one milestone to date

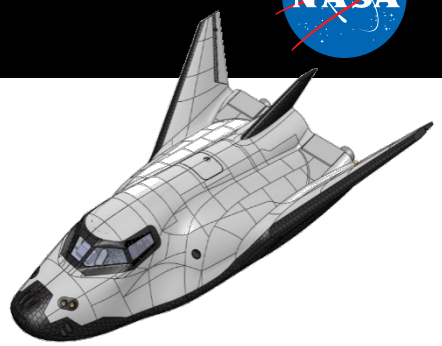
CCP Major Partner Milestones



Blue Origin

- **Entered into a new unfunded Space Act Agreement, April 2016**
  - Purpose: Facilitate progress maturing the design and development of an orbital commercial human space transportation system
  - Scope: Space Vehicle, Reusable Booster System, Launch Vehicle and Ground and Mission Operations
- **Accomplishments**
  - Completed first Technical Interchange Meeting (TIM)
  - NASA provided Blue Origin an accelerometer to be flown on its last flight
    - Flight data to be used jointly by NASA and Blue Origin
- **Look Ahead**
  - Corrosion Control TIM; summer 2016

Sierra Nevada Corporation



- **Space Act Agreement extended to June 2017**
- **Approach & Landing Test 2 – December 2016 flight test**
  - Full scale Dream Chaser Engineering Test Article
  - Unpowered approach & landing test
  - Collect subsonic aerodynamic data to validate wind tunnel and CFD aero results
  - Validation of low-speed aerodynamic flying qualities – stability and control
  - Validate subsonic orbital vehicle flight software and GN&C functionality
  - Demonstrate the fault tolerant flight computer performance
- **Key Activities**
  - Avionics racks installed, all harnesses installed and terminated
  - Bonded “ALL” major Thermal Protection System (TPS) pieces to vehicle and aeroshells
  - Flight Like TPS installed on nose skid
  - Installed side/aft and lower aft aeroshells for flight
  - Completed strain gage calibrations
  - Completed hydraulic system modifications/installation
  - Avionics/Comm checkouts underway

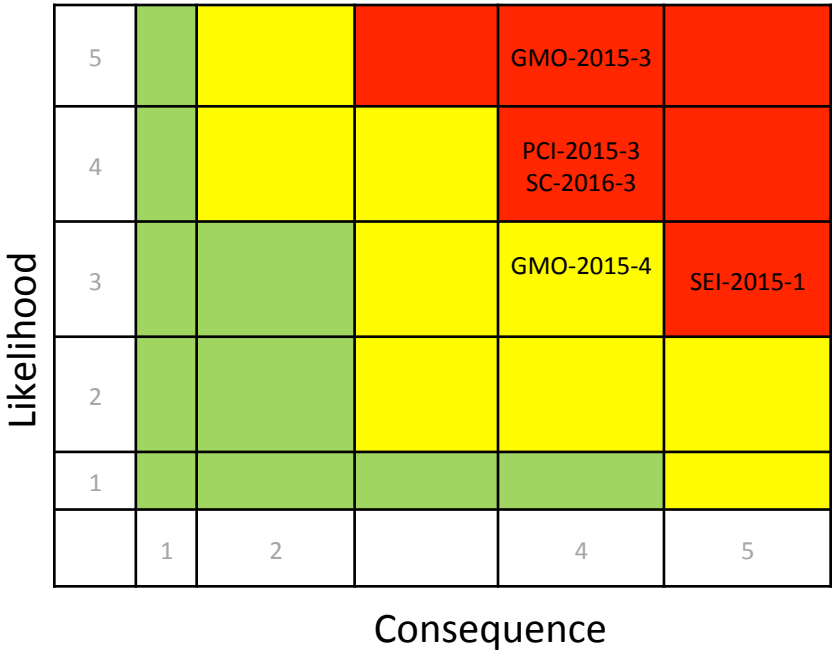
CCP Top Programmatic Risks 6/28/16

Program Control & Integration (PC&I)
- Requirement Changes (PCI-2015-3)

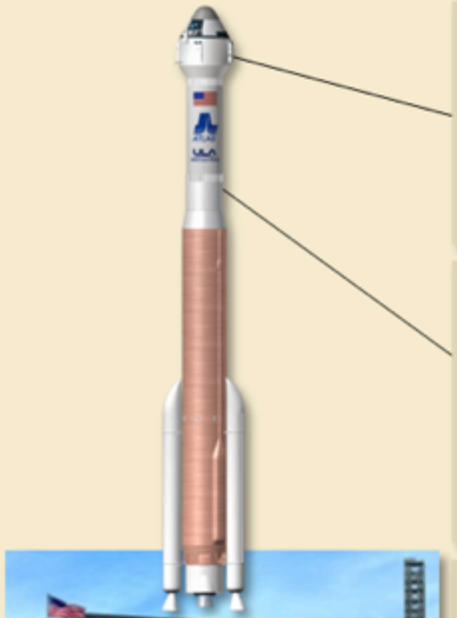
Systems Engineering & Integration (SE&I)
- Ability to Close the LOC Gap (SEI-2015-1)

Ground & Mission Operations (G&MO)
- Search and Rescue Posture (GMO-2015-3)
- DoD Search & Rescue Training Schedule (GMO-2015-4)

Spacecraft
- Ammonia Emergency Response (SC-2016-3)



Boeing Architecture Description



Spacecraft Segment

Simplicity of design with high maturity through use of existing technologies within Boeing and from our key suppliers such as Aerojet Rocketdyne and General Dynamics

- Crew Module
- Service Module
- Flight Software

Launch Segment

Mature design through use of heritage design, production, and operations from our key supplier ULA

- Launch Vehicle
- Launch Control Complex
- Spacecraft / LV Integration
- Launch Pad
- Pad Test and Checkout
- Emergency Detection System

Ground and Operations Segment

Mature design and processes through use of proven Boeing production techniques

- Cargo Integration
- Landing and Recovery
- Network Services
- Assembly, Integration and Test Facility
- Landing Site Facilities

Mature mission operations through use of heritage mission support from our key supplier JSC/Flight Operations Directorate (FOD)

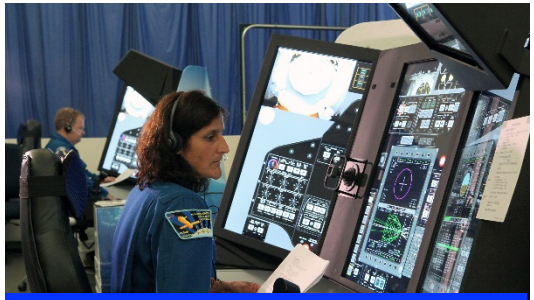
- Crew Training
- Mission Planning
- Mission Operations
- Mission Control Center
- Training Systems

Boeing Accomplishments

- **Design**
  - CST-100 Starliner spacecraft design in firm configuration
  - Design solution selected to address non-linear aerodynamic acoustics and loads – in final stages of wind tunnel testing
- **Demonstration & Test**
  - Water landing qualification tests at NASA Langley complete
  - Part-Task Trainers acceptance testing complete and delivered
  - Parachute qualification testing beginning in August
- **Production & Qualification**
  - Shipped Service Module to California for structural testing
  - Spacecraft 1 docking hatch, upper and lower domes delivered
  - Approximately 40% of components will be in qualification testing within the next 60 days
- **Facility Preparations**
  - Ribbon cutting on Space, Training, Analysis and Review (STAR) Facility
  - Commercial Crew and Cargo Processing Facility (C3PF) at NASA Kennedy getting fleshed out

STAR Facility Open

C3PF Hazardous Processing Facility



Crew Part Task Trainers

SpaceX System Description

- **Spacecraft Segment (Dragon)**
  - Crew Dragon
  - Trunk
  - Launch Abort System (internally integrated in Dragon)
- **Launch Segment (Falcon 9)**
  - Full thrust Merlin engines
  - Densified propellants (chilled LOX & RP-1)
  - Common First stage w/Falcon Heavy design
  - Autonomous Flight Termination System
  - Landing legs (stowed in ascent)
  - Stage separation system
- **Ground and Operation Segment**
  - Launch Operations System
    - Launch Pad (LC39A), Launch Pad facility, Ground SW, & Launch Control Center
  - Mission Operation System
    - MCC (Hawthorne) Crew Ops, Training & Sim, & Recovery

Crew Dragon Vehicle

Falcon 9

Mission Control
Hawthorne, CA

Launch Control
Cape Canaveral, FL

LC-39A
Kennedy Space Center, FL

SpaceX Accomplishments

- **Design**
  - Completed dCDR2 Spacesuit & Trunk TIMs
    - Space suit is currently in fabrication
  - Multiple dCDR2 packages delivered and reviewed
  - Approximately 50% launch site design reviews completed for crew interfaces to LC-39A
- **Demonstration & Test**
  - Completed 6 full thrust flights with load & go operations with densified propellants
  - Completed all 3 demonstration flights needed for Range approval to use Automated Flight Termination System
- **Production & Qualification**
  - 4 Dragon pressure vessel weldments in production
  - Dragon batteries and components progressing through testing
  - Multiple components entering qualification phase and on track for testing

Budget

($ in millions)	FY 2016 *	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
FY 2017 President's Budget	1,243.8	1,184.8	731.9	173.1	35.8	36.3

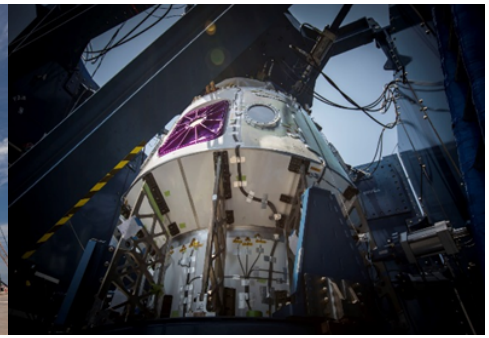
** FY 2016 reflects the amounts in the FY 2016 President's budget which were fully appropriated*

- CCP will continue to manage crew transportation services to ISS after partner vehicles are certified.
- First two Post Certification Missions will be funded by CCP.
- Additional Post Certification Missions are expected to be authorized at a nominal pace of two per year, funded by the Crew and Cargo Program.
- Critical that CCP receive full FY 2017 President's Budget Request to support planned milestones and certification to end sole reliance on Russia for U.S. crew transportation.

Summary

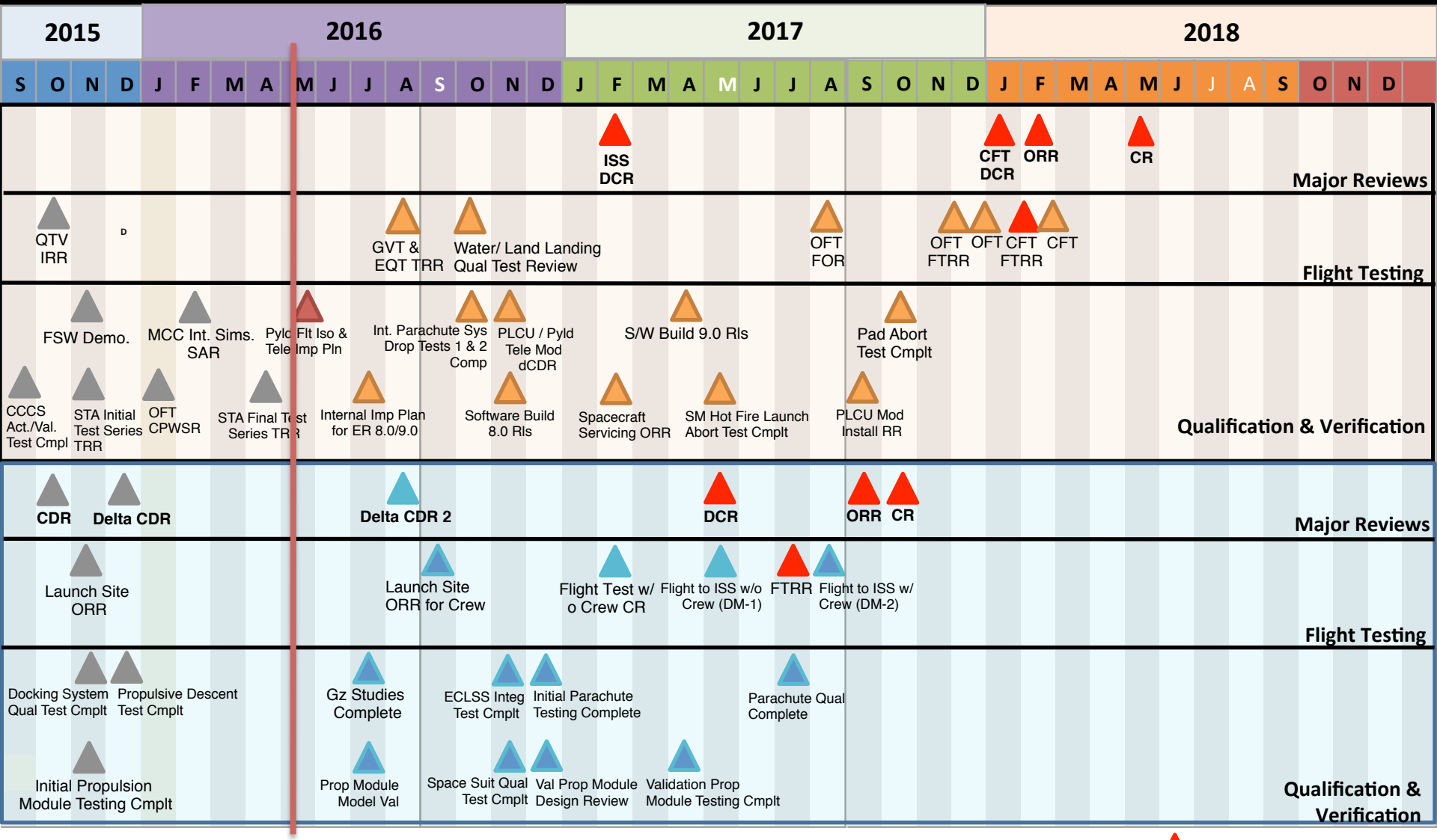
- **Boeing and SpaceX are advancing their design concepts**
  - Actively building and testing hardware to inform design
  - Engaging in meaningful insight with NASA
  - Addressing important design challenges
- **Both providers are providing increased insight opportunities for the NASA team**
- **CCP has robust and efficient processes for certification including addressing waivers and deviations**
- **In preparation for flight, there is significant work ahead**



Back Up

CCtCap Combined Milestone Summary Official – FY16Q2



CCtCap CMS-Official May 20, 2016
Data Source: Boeing FY16Q2 / SpaceX FY16Q2

Required Milestone (RM)
Boeing Milestone
SpaceX Milestone.